THE DISPERSAL BEHAVIOUR OF NORTH SEA COD (*Gadus morhua*)

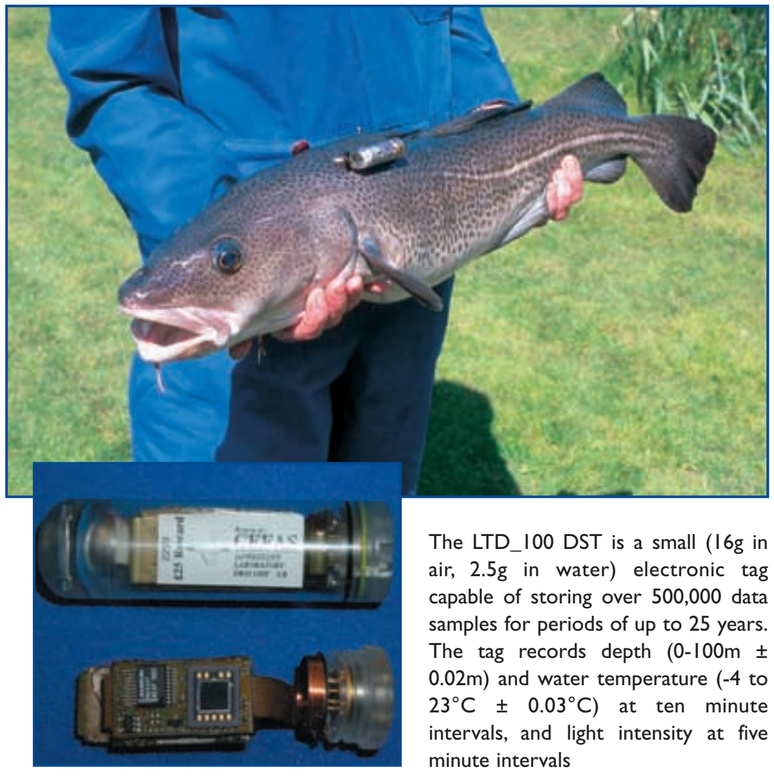
by K. Turner, D. Righton and J.D. Metcalfe

CEFAS
The Centre for Environment, Fisheries & Aquaculture Science

The migratory behaviour of cod was studied using electronic data storage tags (DSTs). Behavioural patterns were used to distinguish between periods of migration and residence on putative feeding grounds. Our results demonstrate that individual-based studies of fish behaviour can provide information relevant to fisheries management.

Introduction

Cod (*Gadus morhua*) is a commercially important demersal species, which makes seasonal migrations between spawning, nursery and feeding grounds. The North Sea stock was once abundant but it is now subject to drastic quota cuts in order to prevent stock collapse. In the future, additional conservation measures will be required to safeguard stock recovery and an increased knowledge of migration patterns and behaviour is needed. However, individual-based studies of free-ranging predatory marine fish species are rarely undertaken because such direct observations of fish behaviour at sea are difficult and costly.



The LTD_100 DST is a small (16g in air, 2.5g in water) electronic tag capable of storing over 500,000 data samples for periods of up to 25 years. The tag records depth (0-100m ± 0.02m) and water temperature (-4 to 23°C ± 0.03°C) at ten minute intervals, and light intensity at five minute intervals

Methods

We used electronic data storage tags (DSTs) to study the behaviour of adult cod in the North Sea.

Fifty-one cod (mean length = 64cm, age 3 years+) were tagged and released off Lowestoft in late March and April 1999. Twenty-two tags (42%) were returned by March 2000, yielding over 1500 days of data. The longest tag record was from an individual that had been at liberty for 224 days.

Hydrostatic data, derived from the sinusoidal pressure cycle recorded in the depth data when a fish is at rest on the seabed, was used to enable the geographical reconstruction of a fish's movements (called geolocations). The resulting positions were then verified where possible using light and temperature data.

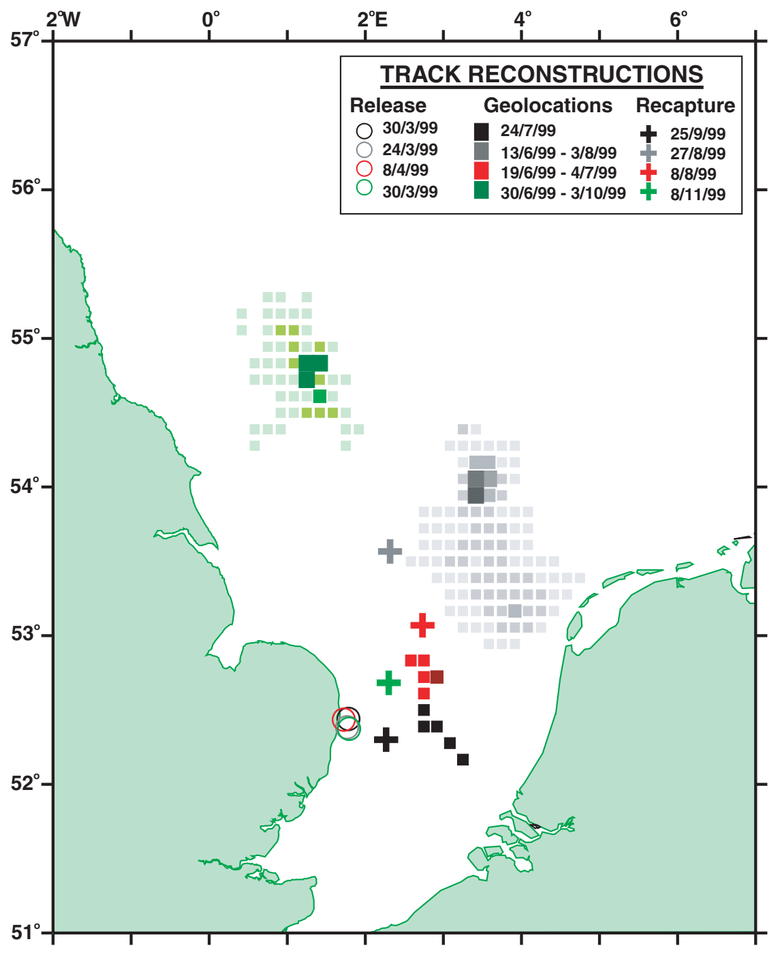


Figure 1: The dispersal of North Sea cod away from a release position. Shaded boxes represent the areas of summer residence, with the density of colour proportional to the number of repeated occurrences of geolocational position.

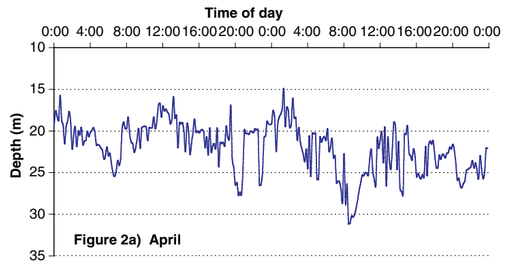
Results - Track reconstructions

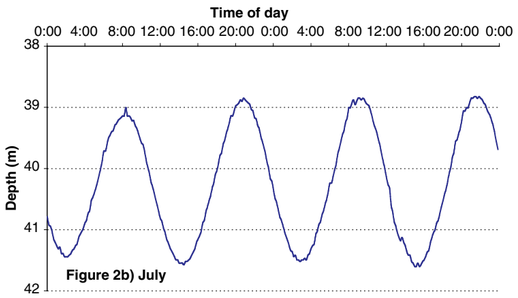
We were able to reconstruct the positions of eight fish and track reconstructions for four of these fish are shown in Figure 1. From the reconstructions it is apparent that these individuals had dispersed to locations across the central North Sea by July 1999. Three of the fish were caught before October 1999 in locations consistent with their geolocated positions. The fourth fish (shown in green) was recaptured in the Southern Bight in November 1999, following a period when it could not be geolocated.

Results - Behavioural patterns

Two main patterns of behaviour were discernible from the tag data.

Between March and June, as individuals migrated north from spawning grounds, they were highly active and spent much of their time swimming in mid-water.





In contrast, from July to September, individuals were predominantly inactive and typically remained on the seabed for most or all of the time. Geographical reconstruction of the tag record during this period places the individuals throughout the central North Sea on putative summer feeding grounds (see figure1).

During October and November, individuals still at liberty switched back to a behavioural pattern of high activity, probably accounting for the migration south to spawning grounds.

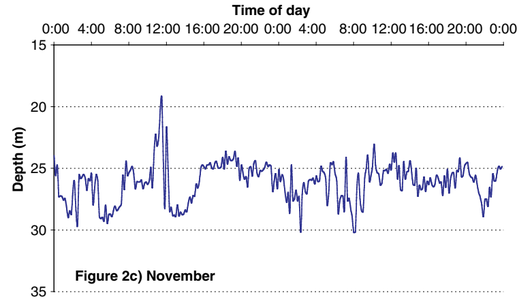


Figure 2a, b, and c: Depth record of an individual cod.

Conclusions

- To our knowledge, this is the first time that cod behaviour has been investigated for such long periods and at such a fine temporal and spatial scale.
- We show that populations of cod show distinct and specific behaviour patterns that persist at a seasonal scale and are related to changes in the range and extent of geographic movement.
- Our data also suggest that cod may enter into a rest period following their post-spawning migration from the Southern North Sea and increase their activity before their pre-spawning migration.
- These results increase our understanding of the processes that underpin dispersal and will contribute to the development of more biologically realistic fisheries management models.

The Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk NR33 0HT, UK http://www.cefas.co.uk